Canadian Aviation Safety Board

Bureau canadien de la sécurité aérienne

Civil Aviation Occurrence Report

Canada

The Canadian Aviation Safety Board investigated this occurrence for the purpose of advancing aviation safety. It is not the object of the Board to determine or apportion any blame or liability.

AVIATION OCCURRENCE REPORT

DE HAVILLAND DHC-2 BEAVER C-GAEE
DEASE LAKE, BRITISH COLUMBIA
27 SEPTEMBER 1986

REPORT NUMBER 86-P60058

SYNOPSIS

The float-equipped Beaver aircraft departed Atlin, British Columbia on a flight to Dease Lake. On board were the pilot and five passengers. At destination, the aircraft was observed in a steep approach for a landing in the middle of the lake, in conditions described by witnesses as glassy water. The aircraft struck the water in a nose-low attitude and nosed over. The pilot escaped with serious injuries, and the five passengers drowned.

The Canadian Aviation Safety Board determined that the pilot did not recognize the glassy-water conditions and did not use the glassy-water landing technique; as a result, the aircraft struck the water in a nose-low attitude.

Ce rapport est également disponible en français.

12 January 1988

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1.0 FACTUAL INFORMATION

1.1 History of the Flight

On 27 September 1986, the pilot and five passengers boarded the float-equipped Beaver aircraft, C-GAEE, in Atlin, British Columbia and departed on a visual flight rules (VFR)* flight to Dease Lake at 1618 Pacific daylight time (PDT).**

The flight arrived over Dease Lake at 1735 and proceeded northward over the lake's east shore (see Appendix A). Approximately one and one-half miles from the south end of the lake, the aircraft turned to the south to descend for a landing in the middle of the lake. The aircraft was in a fairly steep constant descent when it struck the water. It then nosed over and came to rest with only the bottom of the fuselage visible. The fuselage floated for about 10 minutes, then sank in 120 feet of water. The landing area was approximately one mile from the south end of the lake.

The pilot escaped with serious injuries. The five passengers did not exit the aircraft and drowned.

The accident occurred at 1740 during the hours of daylight at lat 58°28'N, long 130°02'W.***

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	-	5	-	5
Serious	1	-	-	1
Minor/None	-	-	-	-
Total	1	5	-	6

1.3 Damage to Aircraft

The aircraft was destroyed when it struck the water.

* See Glossary for all abbreviations and acronyms.

** All times are PDT (Coordinated Universal Time (UTC) minus seven hours) unless otherwise noted.

*** Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.

1.4 Other Damage

-Nil-

1.5 Personnel Information

Age	39
Pilot Licence	Commercial
Medical Expiry Date	01 August 1987
Total Flying Time	1,900 hr
Total on Type	1,000 hr
Total Last 90 Days	300 hr
Total on Type Last 90 Days	200 hr
Hours on Duty Prior to Occurrence	9 hr
Hours off Duty Prior to Work Period	16 hr

The pilot's licence was endorsed for float privileges in 1983. She had accumulated approximately 700 hours of float operation time and had operated in glassy-water conditions on numerous occasions.

1.6 Aircraft Information

Manufacturer	de Havilland
Type	DHC-2 Beaver
Year of Manufacture	1954
Serial Number	724
Certificate of Airworthiness	Valid
Total Airframe Time	9,750 hr
Engine Type	Pratt & Whitney R985
Propeller Type	Hamilton Standard 2030-405/AG100-2
Maximum Allowable Take-off Weight	5,090 lb
Recommended Fuel Type	80/87

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

The aircraft was configured to carry a pilot and six passengers. On this flight, the pilot and one passenger occupied the front seats, two passengers occupied the centre bench seat, and two passengers were in the rear seat.

The pilot's seat had been modified to accommodate the pilot's small stature. It had a seven-inch-thick back cushion, and a three-inch-high box of survival gear was placed under the seat cushion. When seated on these cushions, the pilot was able to operate the control column freely over its full range.

The weight and centre of gravity were within the prescribed limits.

1.7 Meteorological Information

Environment Canada operates a weather station at Dease Lake Airport which is located approximately two miles from the accident site. An observation taken at 1700, approximately 35 minutes prior to the occurrence, indicated sky condition 1,400 feet scattered cloud, 2,800 feet scattered cloud, estimated 8,000 feet broken cloud; visibility more than 15 miles, temperature 5.6 degrees Celsius, dew point 1.7 degrees Celsius, and wind 230 degrees true at one knot. Another observation taken 1 hour and 25 minutes later reported similar conditions with winds calm.

Witnesses on the lake shore at the time of the accident reported that both wind and water were calm.

1.8 Aids to Navigation

-Nil-

1.9 Communications

The flight departed from and arrived at an uncontrolled seaplane base. It was also conducted over a sparsely populated area, and thus there were no reported radio communications throughout the entire length of the flight.

1.10 Aerodrome Information

Dease Lake is a privately licensed water aerodrome that uses the southern end of the lake for the landing area. The lake, oriented north/south, is approximately 3,500 feet wide at the south end and is 2,467 feet above sea level. This 26-mile-long lake is situated in a valley with hills rising to 500 feet above lake level on the east and west sides. There are no other restrictions or

obstructions to landing aircraft. The south end adjoins a large muskeg area over which the local operators approach for a reference during periods of glassy-water operations.

1.11 Flight Recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was either required by regulation.

1.12 Wreckage and Impact Information

The aircraft struck the water on a heading of 160 degrees magnetic, nosed over, and sank in 120 feet of water. Both wing mounts failed forward upon impact, damaging the wing tips, pinching the fuselage at the top of the windscreen, and breaking the windscreen. All fuselage/wing attachments including the wing spar, fuel lines, and control lines were torn forward during the accident.

The aircraft's floats were torn off on impact. The front six feet of both float tips were torn from the floats and were compressed upward approximately 30 degrees prior to failure.

The wing flap position indicator was located half-way between the LANDING and TAKE-OFF position. The wing flap actuating cylinder extension coincided with the wing flap position indicator. The hydraulically operated wing flap system tested serviceable following the accident.

There were sufficient life-jackets on board the aircraft to accommodate both the pilot and passengers. All life-jackets were still in their storage pouches.

The top of the fuselage just aft of the wing mounts was crushed inward approximately eight inches by water load when the aircraft nosed over. The remainder of the fuselage remained intact, and all doors operated normally. The engine was driven back into the firewall on impact, then torn from the mounts as the aircraft nosed over.

There were no known unserviceabilities or structural failures prior to impact.

1.13 Medical Information

1.13.1 Pilot

There was no evidence that incapacitation, physiological, or psychological factors affected the pilot's performance.

1.13.2 Passengers

Both rear-seat passengers sustained head injuries that could have caused unconsciousness. The remaining three passengers had minor injuries that would not have caused a loss of consciousness. All five passengers died from drowning.

Toxicological reports indicated that two of the five passengers had blood carboxyhemoglobin saturation levels ranging between 11 and 14 per cent. (Carboxyhemoglobin represents the level of carbon monoxide in the blood.) One of the two passengers was seated in the centre seat, and the other one was seated in the rear seat. Both of these passengers were heavy smokers. Carbon monoxide levels up to 10 per cent have been found as a result of smoking, and values higher than 15 per cent have occasionally been encountered. The two passengers in the centre and rear seats and the front passenger all had blood carboxyhemoglobin saturation levels below seven per cent.

The passenger in the co-pilot seat was a large man. Toxicological reports indicated that he had a blood-alcohol level of 110 milligrams per cent (mg%). By comparison, the legal limit for driving in Canada is a blood-alcohol level of 80 mg%.

1.14 Fire

There was no evidence of fire either before or after the occurrence.

1.15 Survival Aspects

The aircraft has four doors, two on either side of the fuselage (see Appendix B). All doors are unlatched by means of a recessed rotary knob. When the centre seat is installed, the rotary knob for opening the rear door is behind the seat; thus, the door cannot easily be opened by passengers sitting in the centre seat. Passengers in the rear seat have ready access to the

handle and can easily unlatch the door but, because of the centre seat position, cannot get out of the aircraft until the centre seat passengers have disembarked and that seat back is folded forward. All doors and door handles were appropriately marked.

The passenger briefing cards displaying flight safety and survival equipment conformed to existing regulations. This information included the operation of seat-belts and doors, plus the location and operation of life vests and survival equipment. The passenger briefing given by the pilot covered the same information. Neither the cards nor the pilot briefing addressed evacuation from a submerged cabin.

The pilot was the only survivor. She reported that, although she was disoriented, she was able to exit the aircraft through the broken windshield. She was rescued approximately 10 minutes later by a local aircraft charter operator who kept a boat ready for emergencies. The lake is very clean with underwater visibility in excess of 30 feet.

The pilot confirmed that all seat-belts had been fastened prior to take-off. All seats and seat-belts remained intact, and the seat-belt release mechanisms were all serviceable. The seat-belt of the passenger in the co-pilot seat and those of the two passengers in the rear seat were unfastened when the wreckage was examined. The two passengers in the centre seat had their seat-belts fastened. All passengers were found in or adjacent to the seating positions they occupied prior to the crash. The aircraft was not equipped with shoulder harnesses.

1.16 Tests and Research

- Nil -

1.17 Additional Information

1.17.1 Glassy-Water Phenomenon

A glassy-water landing is a potentially dangerous situation in which the water surface appears mirror-like. The pilot, unable to focus on the transparent water surface, suffers a loss of depth perception and is unable to accurately judge height above the water. When landing under glassy-water conditions, the pilot will sometimes be looking at

reflections in the water or even at the bottom of the lake and not at the surface of the water. To ensure a safe landing, a glassy-water technique must be used.

1.17.2 Glassy-Water Landing Techniques

A glassy-water landing in a Beaver aircraft is an approach that ensures a nose-up attitude with minimum rate of descent upon water contact. It is a power-on landing conducted near and parallel to the shore to maintain a visual reference above the water. Flap setting is either minimal or a flap setting that will give the best nose-up attitude. Aircraft speed is maintained at approximately 10 knots above the stall speed. Engine power should be adjusted to maintain a rate of descent of 100 to 200 feet per minute. Upon water contact, the pilot must simultaneously close the throttle and apply back pressure on the aircraft controls to overcome the natural nose-down tendency caused by float drag.

1.17.3 Witness Observations

A private pilot with a float endorsement, who was located at the end of the lake, reported that the descent was constant until water impact. A commercial pilot with a float endorsement reported that, on the final descent to landing, the aircraft was in a stable "nose-down attitude" until water contact. The latter pilot had landed at the lake approximately 20 minutes before the accident and reported that he had encountered glassy-water conditions.

The accident pilot reported that the flight was normal until approximately 200 feet above the water. She reported that she was able to see the water surface clearly because of surface undulations and ducks swimming on the lake, and she chose to complete a landing away from the shore. The pilot was unable to recall any details of the event from the 200-foot altitude to the point at which she commenced her evacuation from the submerged aircraft.

2.0 ANALYSIS

2.1 Introduction

The analysis focuses on weather-induced perceptions and pilot performance, and on how these two factors combined to result in this accident. The analysis also focuses on why this potentially survivable accident resulted in five fatalities.

2.2 Weather-Induced Perceptions

The weather conditions were such that glassy water could be expected. The broken sky condition would have muted the light, reduced surface reflections, and compounded problems of depth perception. These conditions are consistent with eyewitness reports.

2.3 Final Flight Path

The commercial pilot who witnessed the accident reported that the aircraft, compared with a normal approach, descended in a "nose-down attitude" until water contact. This report is consistent with impact damage sustained by the aircraft on water contact.

The accident pilot reported that, during the circuit, landing conditions were not assessed as glassy, because wave undulations and birds swimming on the lake made the lake surface appear quite visible. Thus, she did not consider it necessary to use a glassy-water technique on landing.

From circuit altitude, with both lake shores visible for reference, accurate altitude information would be perceived, and the water surface would, as reported by the pilot, be clearly defined. Once in descent over the lake, however, the lake shores were too far away to provide any meaningful size comparison that could have been used for altitude judgement. The wave undulations and bird activity as reported by the pilot also provided insufficient cues for a normal approach and landing. As a consequence, the pilot perceived the aircraft to be at a higher altitude than its true altitude, and the aircraft struck the water during the descent.

2.4 Survivability

Witness reports indicate that the aircraft descended in a fairly steep stable approach until water contact.

The injuries sustained by the pilot and passengers were not incapacitating in nature; therefore, deceleration forces must have been within the limits of human tolerance. Because the passengers were not thrown forward on impact, but were found in or close to their respective seats, it is concluded that all had followed the pilot's instruction to ensure that their seat-belts were fastened. Three of the five passengers had unfastened their seat-belts, yet they were unable to exit the aircraft.

2.5 Emergency Evacuation

The pilot reported that, after impact, she was disoriented because the fuselage was submerged in an inverted position. Having flown the aircraft for 1,000 hours, she was very familiar with the aircraft exits, yet she exited through the broken windscreen. Her familiarity with the cockpit allowed her to reason that water flowing into the cabin could only come from a broken windscreen, through which she could escape. This knowledge was instrumental in her survival.

The passenger occupying the co-pilot's seat was not familiar with the aircraft. His seat was beside the front door and behind the broken windscreen. Although post-mortem analysis indicated that his blood-alcohol level was 110 mg%, he was able to unfasten his seat-belt in preparation for escape. He did not, however, open the door nor escape through the broken windscreen. It is possible that the lack of a planned escape route, coupled with disorientation and the effects of alcohol, prevented his escape.

The two passengers in the centre seat were recovered with their seat-belts fastened. They were not incapacitated due to injuries received in the accident. The reason why they did not unfasten their belts and attempt to exit the aircraft could not be determined. They, too, may not have pre-planned their evacuation in an emergency.

Post-mortem reports indicate that the two passengers in the rear seat had sustained head injuries of a nature that could have caused unconsciousness. However, since both had unfastened their seat-belts, both must have been conscious following the accident. To escape from the submerged upside down fuselage, the passengers would have had to find the recessed door handle and open the door, overcoming static water pressure. If they were able to get the door open, they would have then had to push forward the centre seat-back and centre seat

occupants so that they could exit. Thus, for these two passengers, pre-planning for an emergency evacuation would have been particularly important. It is possible that the lack of planning coupled with the effects of their injuries and disorientation prevented their escape.

Passengers' knowledge of where the emergency exit is located, how they are going to get to it, and how to operate it is vital to survival in emergency circumstances. The verbal passenger briefing and briefing card both covered basic flight safety and survival information. However, neither briefing method stressed the need for the passenger to note his position relative to an exit and the necessity for him to formulate a plan on how to evacuate the aircraft in an emergency situation. Had such information been available to these passengers, their chances of survival would have been enhanced.

2.6 Carbon Monoxide Levels

Since carbon monoxide levels greater than 10 per cent were found in two of the passengers, incapacitation was considered. These carbon monoxide levels were comparable to levels usually found in heavy smokers. The specimen analysis indicated the presence of nicotine and cotinine, a metabolite of nicotine. The carbon monoxide levels were considered to be the result of cigarette smoking and not due to an aircraft system malfunction.

3.0 CONCLUSIONS

3.1 Findings

1. Glassy-water conditions prevailed at the time of the landing.

2. The aircraft struck the water at a high rate of descent, in a nose-down attitude.

3. The passenger pre-flight briefing/card did not adequately prepare passengers to deal with emergency water evacuation.

4. The pilot was certified and qualified for the flight in accordance with existing regulations.

5. The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

6. There was no evidence found of any airframe failure or system malfunction prior to or during the flight.

7. The weight and centre of gravity were within the prescribed limits.

3.2 Causes

The cause of the accident is that the pilot did not recognize the glassy-water conditions and did not use the glassy-water landing technique.

4.0 SAFETY ACTION

4.1 Action Required

4.1.1 Passenger Safety Briefing - Float-Equipped Aircraft

Float-equipped aircraft operations present unique hazards for passengers and crew. Accidents during the take-off or landing phase of flight can result in the aircraft turning over and rapidly filling with water. While the crash forces are in most cases survivable, occupants of an overturned aircraft can easily become disoriented, panic-stricken, and unable to remove themselves from a life-threatening environment. Additionally, the design and operation of door-latching mechanisms found on some aircraft types may inhibit the easy egress of passengers and crew from aircraft. Recessed door-opening mechanisms, such as those found on the Beaver aircraft, may be difficult to operate under conditions of duress. The CASB believes that, under such circumstances, a carefully pre-planned escape route and familiarity with the location and operation of aircraft exits are essential for survival. Passenger safety briefings, including the briefing cards, can increase the likelihood of a successful evacuation from an aircraft after an accident on the water, particularly if the aircraft is submerged or inverted, by emphasizing the need to pre-plan escape routes.

The Board believes that the lack of specific direction to passengers of float-equipped aircraft regarding emergency evacuation procedures in the event of a water-related accident decreases the likelihood of passengers being able to successfully exit the aircraft. Moreover, ANO Series VII, No. 3, does not clearly specify the briefing requirements for such eventualities. Therefore, the CASB recommends that:

> The Department of Transport require float-equipped air carriers to include, as part of pre-flight safety briefings, specific instructions on pre-planning emergency egress paths, as well as on the operation of emergency exits.
>
> (CASB 88-01)

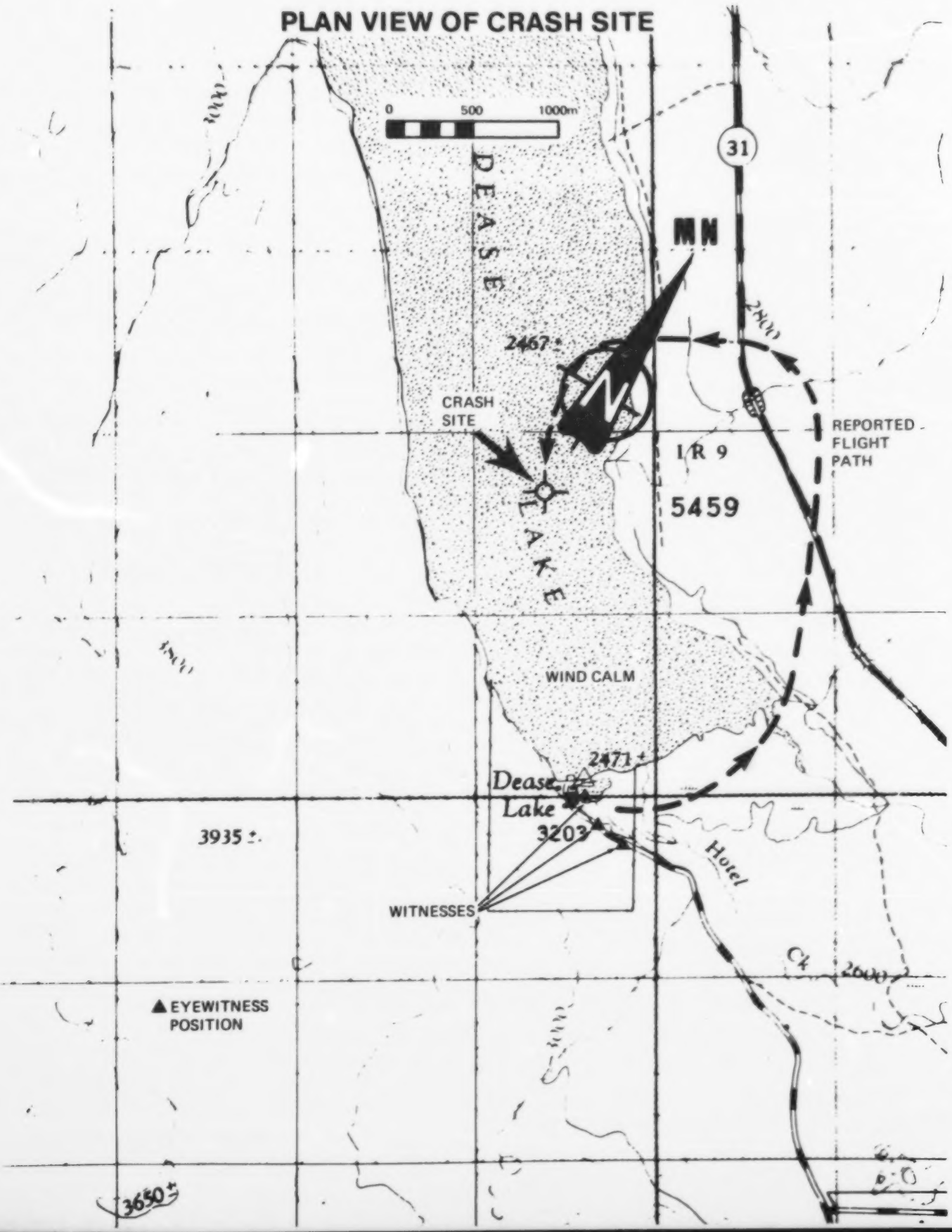
4.2 Other Safety Concern

The Board is concerned that egress from the Beaver aircraft may be hampered due to difficulties in reaching and operating the recessed rotary door handle, particularly when the centre bench seat is installed. The Board is cognizant of the fact that the Beaver aircraft is over 40 years old and was not designed to today's more stringent design criteria. Nevertheless, there are still approximately 400 Beavers on the Canadian Civil Register, many of them on floats. In the 10-year period between 1976 and 1986, there have been some 125 Beavers involved in floatplane accidents, accounting for 13 fatalities when the aircraft became inverted or submerged post-impact. The design of the door-opening mechanism found on the de Havilland Beaver (in particular, the recessed handle and the lack of an emergency door jettisoning capability) was the subject of a recent Aviation Safety Advisory to Transport Canada. The Board will continue to monitor potential design deficiencies for emergency egress from float-equipped aircraft and will make Aviation Safety Recommendations if warranted.

This report and the safety action therein has been adopted by the Chairman, Bernard M.-Deschênes, Q.C., and Board Members:

Norman Bobbitt
Leslie Filotas
Roger Lacroix
William MacEachern
Arthur Portelance
Bruce Pultz
Ross Stevenson
Frank Thurston

PLAN VIEW OF CRASH SITE

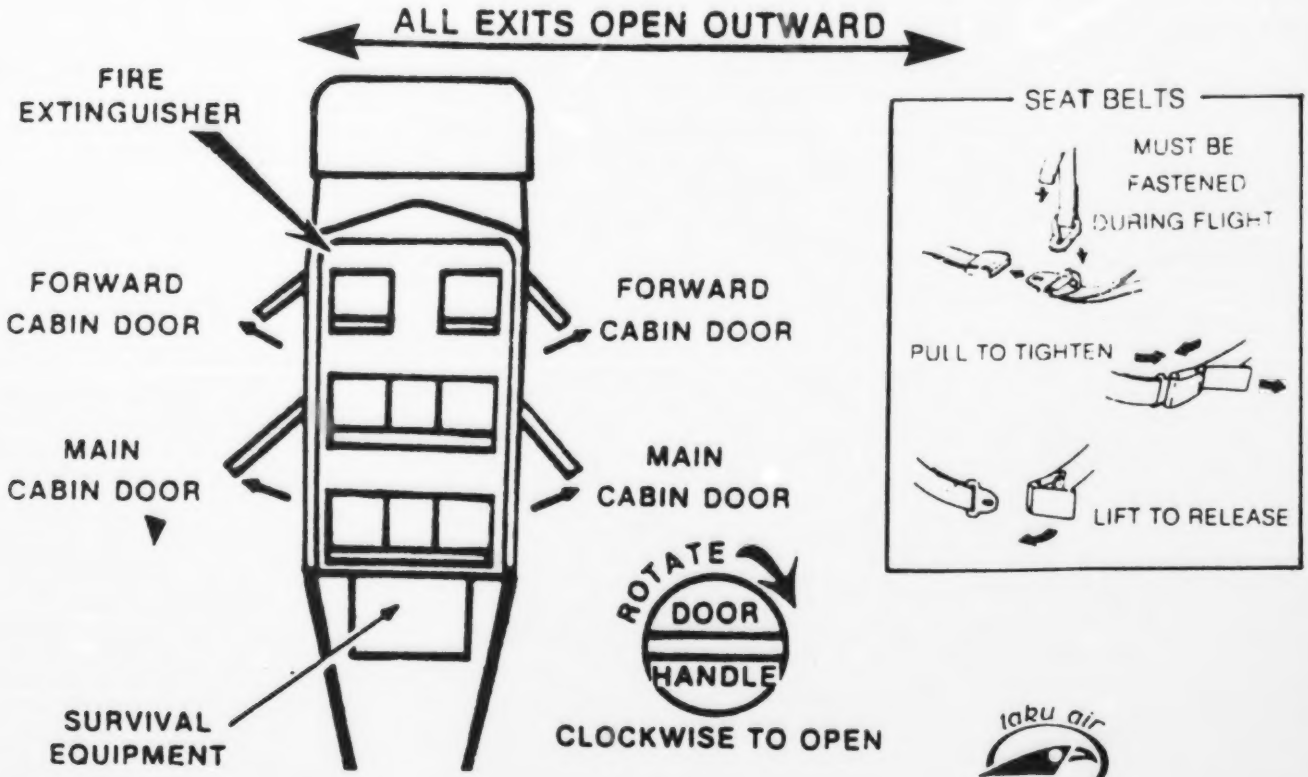


DHC-2 BRIEFING CARDS

DEHAVILLAND BEAVER SAFETY INFORMATION

- KEEP SEAT BELT FASTENED DURING FLIGHT.
- NO SMOKING DURING TAKEOFFS AND LANDINGS.
- FIRE EXTINGUISHER IS LOCATED FORWARD OF LEFT FRONT SEAT.
- LOCATION AND OPERATION OF EXITS IS ILLUSTRATED BELOW.
- PLEASE FAMILIARIZE YOURSELF WITH THESE EXITS.
- SURVIVAL EQUIPMENT IS LOCATED AFT OF THE REAR SEATS, UNDER THE REAR BAGGAGE COMPARTMENT.
- FLOTATION VESTS ARE LOCATED BEHIND THE SEATS IN SEAT POCKETS.

INSTRUCTIONS FOR USE OF ATTACHED TO FLOTATION VESTS



BOX 145, ATLIN, B.C., V0W 1A0

① PULL DOWN OVER HEAD

[illegible] LE GILET AUTOUR DU COU

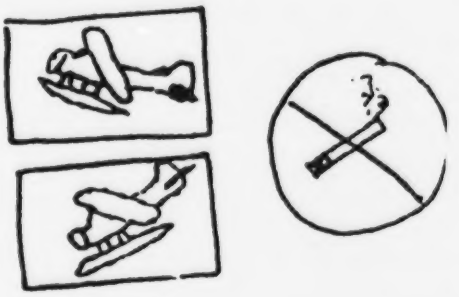
BOX 145, ATLIN, B.C., V0W 1A0

⑤ TO INFLATE ORALLY BLOW INTO ORAL TUBES

POUR GONFLER ORALEMENT, SOUFFLEZ DANS LES TUBES

② FASTEN SNAPS TO RING

ACCROCHEZ LES MOUSQUETONS A L'ANNEAU



③ PULL STRAPS TIGHT

TIREZ SUR LES SANGLES POUR SERRER LA CEINTURE

④ TO INFLATE JERK DOWN ON RED PULLS

POUR GONFLER TIREZ SECHEMENT SUR LES CORDONS ROUGES

PULL FOR LIGHT

TIREZ POUR ALLUMER

APPENDIX C

GLOSSARY

hr	hour(s)
lat	latitude
lb	pound(s)
long	longitude
mg%	milligrams per cent
N	north
PDT	Pacific daylight time
UTC	Coordinated Universal Time
VFR	visual flight rules
W	west
°	degrees
'	minutes